Fairness and Ethical Analysis of Voice-Operated Smart Assistants

Team 2
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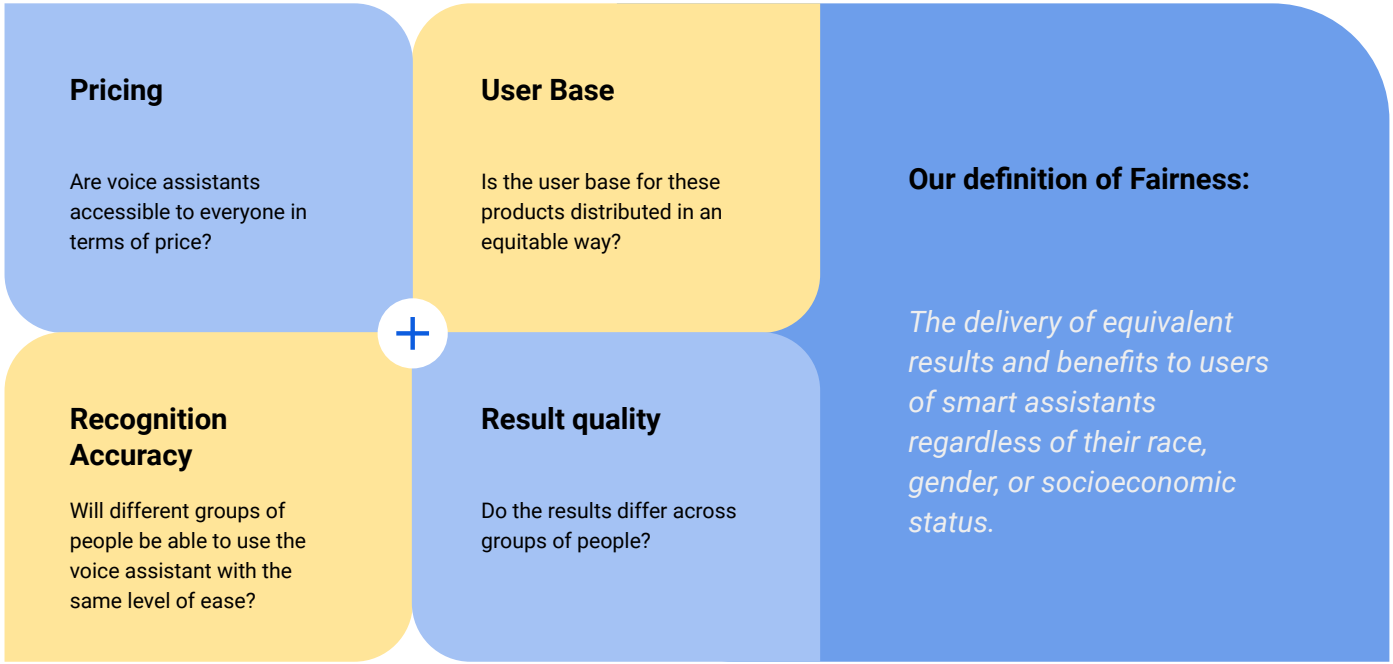
Agenda

I. **Fairness**
   A. Pricing
   B. User Base
   C. Accuracy
   D. Quality
   E. Ethical Implications

II. **Privacy**
   A. Data Collection
   B. Ethical Perspectives on Data Privacy
   C. Establishment terms of privacy

Are voice assistants fair?

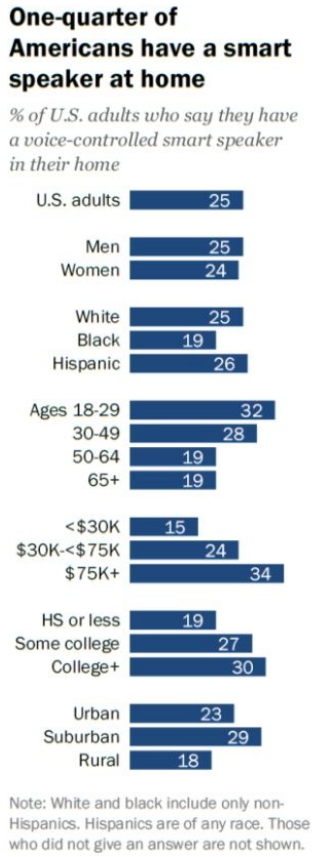


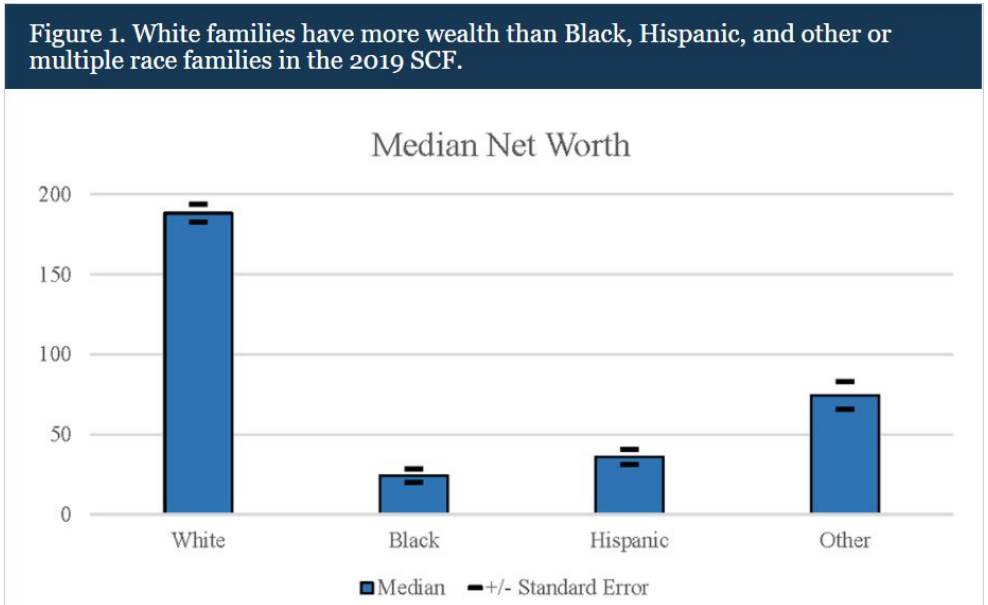
Fairness in Accessibility through Pricing

- 85% of individuals in US have access to a voice assistant through their phone
- No significant disparities in smartphone ownership across genders and race in the US (see Appendix 1)
- Smartphones are often viewed as a necessity

- Only 25% of individuals in the US own a voice-operated smart speaker
- Smart speakers from the top companies in this industry start at $50
- Significant disparities regarding ownership in households with different incomes
- Smart speakers are not generally viewed as a necessity

How Accessibility Affects User Base.





Based on wealth distribution statistics, it is possible to assume that the User Base of voice operated smart assistants is biased towards caucasian people.

Fairness in Voice Recognition

Racial disparities in automated speech recognition

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Article | Figures & SI | Info & Metrics | PDF

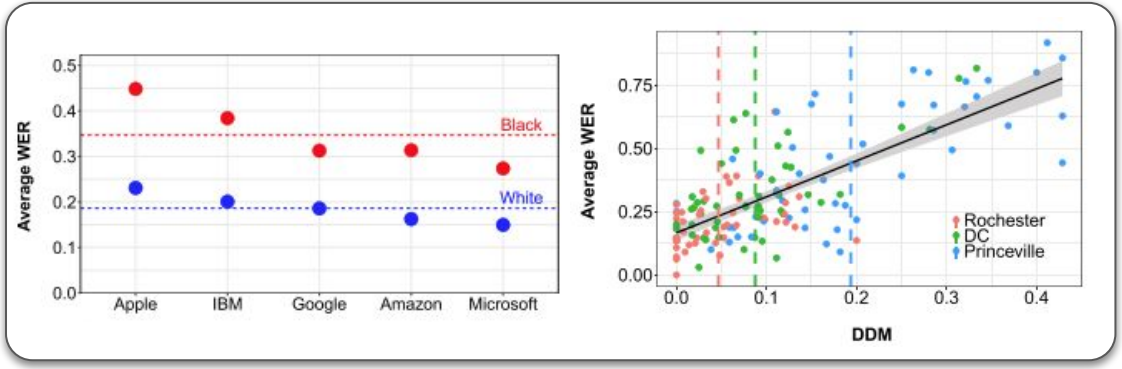
Significance

Automated speech recognition (ASR) systems are now used in a variety of applications to convert spoken language to text, from virtual assistants, to closed captioning, to hands-free computing. By analyzing a large corpus of sociolinguistic interviews with white and African American speakers, we demonstrate large racial disparities in the performance of five popular commercial ASR systems. Our results point to hurdles faced by African Americans in using increasingly widespread tools driven by speech recognition technology. More generally, our work illustrates the need to audit emerging machine-learning systems to ensure they are broadly inclusive.

Study used various automated speech recognition (ASR) systems to transcribe structured interviews conducted with 42 white speakers and 73 black speakers.
https://www.pnas.org/content/117/14/7684

WER: Word Error Rate

DDM: Dialect Density Measure



On average, ASRs misclassified words…

- 19% of the time during the interviews with white people
- 35% of the time during the interviews with black people.

"Fairness is one of our core AI principles, and we're committed to making progress in this area. We've been working on the challenge of accurately recognizing variations of speech for several years, and will continue to do so."

- Google spokesperson to the Verge

Disparities in functionality and quality of results

Controlling for voice recognition, the quality of results should be the same...

"Hey Siri, what's the weather like today?"

In practice, people with smart homes will receive more utility due to increased functionality.

- "People with higher incomes are more likely to use the IoT, which enables them to subsequently develop IoT skills, thus resulting in a greater diversity of IoT use." (Van Der Zeeuw, Van Deursen, & Jansen, 2019).
- Higher education & higher incomes → greater IoT use

Potential relation to voice recognition:
Higher incomes get more utility → more likely to use voice assistants → more data points for people with higher incomes → further propagate issues with voice / speech recognition quality

Ethical Frameworks on Fairness in Voice Assistants

By our definition, the use and accessibility of voice assistants is **unfair**, since different groups of people experience different benefits and results when using the technology.

Consequential

Because the **benefits outweigh the harm**, voice assistants are good regardless of fairness.

Deontological

Nobody should have access to this kind of technology since it can be unfair to different groups of people.

Virtue Ethics

Because the intentions for voice assistants are good, fairness is irrelevant.

Talking Point:

- What do you think? Which do you align most with?
- Does your opinion change when the application of the technology is not for voice assistants?

Privacy

Data Collection

Basic Account Information

Google / Amazon / Apple

- Name
- Address
- Credit Card
- Contacts
- Calendar Events
- Purchase/Subscription

Voice Recordings

- Improve speech recognition functionality
- Keywords from commands are given to third party apps

Pattern and Activity Information

- Patterns that users exhibit are used by devices to recommend or suggest future actions
- Location of a device in the home
- Other home devices in the network

Benefits & Risks of Virtual Assistants

Potential Upsides

- Cheap & smart personal assistants for everyone, not just CEOs
- Conversational companionship to people who are lonely
- Cut Cost for Customer Services Departments for Companies

Potential Downsides

- Unethical Data misuses by service providers like FAANG
- Give hackers more sparse data
- NLP Technology doesn't improve even we have sacrificed privacy
- Break into homes remotely

Ethical Frameworks on Privacy

Privacy here represents private data like virtually existing personal information and physically existing personal living ownership like access to doors etc.

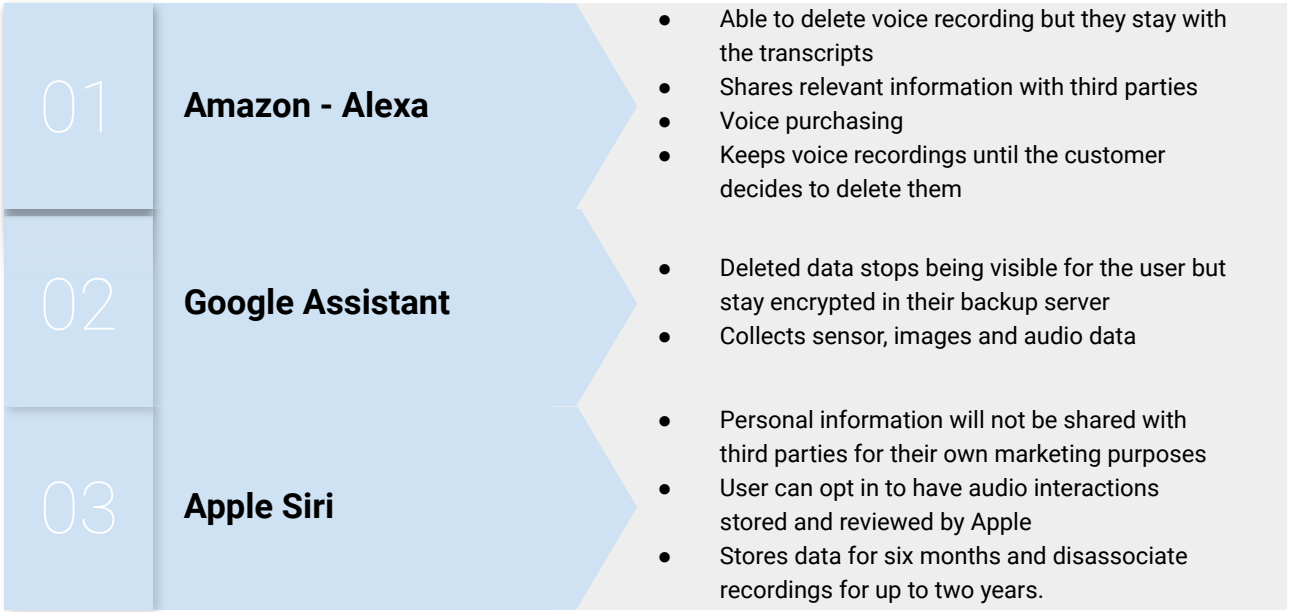
Consequentialism:

Even though there exists a risk of data leakage, the **cost** of privacy seems **little** compared to the potential convenience that voice assistants are expected to bring to our lives like any revolutionary invention products in the past.

Deontology:

No matter whether voice assistants' usage will be super powerful as the technology develops or not, the pure **act** that giant companies know about this problem and still continuing selling those products is deemed **unethical** in deontology.

Virtual Assistants - Terms of privacy and data retention



Talking Point:

- Are the terms of privacy clear and concise? Is this enough or fair?
- Do you feel more comfortable knowing the terms of privacy for your smart-home virtual assistant?

Is the privacy trade-off worth it?

Loss of privacy is an inevitable consequence of technological progress

As technology keeps growing, we need to be aware that we are going to continue losing privacy. Virtual Assistants have many advantages such as helping you keep your home safe, save money in bills and make your life easier. We just can't stop benefiting from new technologies because we are worried about privacy issues. Companies need the data to keep improving their technologies and eventually improving our day by day.

Balance between performance and privacy

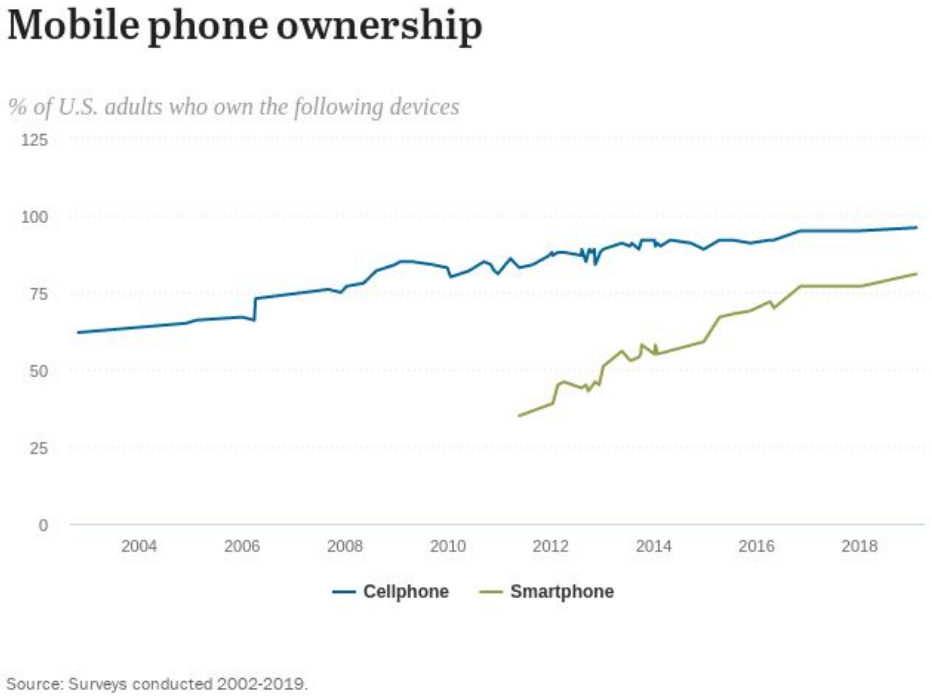
Yes, technology is important and is part of our day by day, but we should still have the right to our privacy. Data retention policies should be created, and companies should comply with them. These regulations should be fair with both sides and allow companies to improve their services while ensuring our privacy.

Q&A

Appendix 1 - Smartphone ownership in the US

% of U.S. adults who say they own a ...

	Cellphone	Smartphone	Cellphone, but not smartphone
Total	97%	85%	11%
Men	97%	85%	11%
Women	98%	85%	12%
Ages 18-29	100%	96%	4%
30-49	100%	95%	5%
50-64	97%	83%	12%
65+	92%	61%	29%
White	97%	85%	11%
Black	99%	83%	15%
Hispanic	100%	85%	14%
High school or less	96%	75%	19%
Some college	98%	89%	9%
College graduate	98%	93%	5%
Less than $30,000	97%	76%	19%
$30,000-$49,999	97%	83%	14%
$50,000-$74,999	97%	85%	12%
$75,000+	100%	96%	3%
Urban	98%	89%	9%
Suburban	97%	84%	12%
Rural	94%	80%	14%



https://www.pewresearch.org/internet/fact-sheet/mobile/

Appendix 2 - Terms of use/privacy

Amazon - Alexa[8]	**Google Assistant**[9]	**Apple - Siri**[10]
➔ Amazon processes and retains your Alexa Interactions, such as your voice inputs, music playlists, your Alexa to-do and shopping lists, in the cloud to provide, personalize and improve the services. ➔ No audio is stored or sent to the cloud unless the device detects the wake word (or pressing the Alexa button) ➔ You can delete voice recordings one by one, by date range, by Alexa-enabled device or all at once. ➔ There is an option to not save any voice recording or automatically delete them in a period of time. ➔ If you choose not to have any voice recordings saved, Amazon retains the text transcripts for 30 days ➔ You can configure voice purchasing. You can require a confirmation code, turn purchasing off, etc. ➔ Amazon could keep records of the requests even after the voice recording is deleted (transcripts, actions Alexa took, etc.) Third parties – any Alexa skill, service, application provided by a third party ➔ Amazon shares relevant information with third parties such as your Zip Code for weather app, music playlist for music applications, etc. Amazon keeps voice recordings until the customer decides to delete them.	➔ Google assistant is designed to wait in stand by model until it is activated (Wake word: “Hey Google”) ➔ If you use voice assistant to make a call, it collects call and message log information like your phone number, calling-party numbers, receiving-party number, forwarding numbers, sender, and recipient email address, time and date of calls and messages, duration of calls, routing information and types and volumes of calls and messages. ➔ It collects sensor data (ambient light measurements, temperature, humidity, carbon monoxide and smoke levels) ➔ Audio and video data from devices with cameras and microphones and information derived from this data (coughing, snoring, facial recognition, activity detection, etc.). ➔ Data can stop being visible to you but stay in Google backup systems. The company encrypts to make sure the data is unreadable and inaccessible.	➔ Personal information will not be shared with third parties for their own marketing purposes. However, Apple may use, transfer and disclose non-personal information for any purpose ➔ Apple stores transcripts of your interactions with Siri and Dictation and may review a subset of these transcripts. ➔ The user can opt in to have the audio interactions stored and reviewed by Apple ➔ Stores data for six months where it dissociates from the audio recording random identifier ➔ After six months, it could be retained for up to two years for ongoing improvement of Siri.